UC **SANTA BARBARA**

Department of Earth Science

Speakers Club

WEBB 1100 • THURSDAY May 30th. • 2:00 PM

Constraining magma budgets at Kilauea Volcano: a new application of the Magma Chamber Simulator

Melissa A. Scruggs
Department of Earth Science, UCSB

As the longest-lived, nearly-continuous eruption in the last 600 years at Kilauea Volcano, the 1983– 2018 Pu'U' O'o eruption has fascinated both the public and earth scientists around the world for over three decades. Rapid technological advances throughout the duration of the Pu'U' O'o eruption have afforded earth scientists a natural laboratory: Kilauea is the best monitored and most intensely studied volcano in the world, serving as the archetype for intraplate Ocean Island Basaltic (OIB) volcanism.

Current methods of quantifying magma supply rates to Kilauea Volcano (and other volcanoes around the world) are based primarily on volatile emissions, effusion rates, and geodetic measurements. In this study, I test whether the geochemical and petrological signatures of Episode 54 lavas[1] (erupted 30-31 January 1997) are consistent with published GPS-based geodetic inversions of ground deformation and dike formation[2] for that event. This is accomplished by applying open-system phase-equilibria thermodynamic models to constrain magma supply volumes for the Episode 54 eruption, and the subsequent return to quasi-steady-state eruption (31 January 1997 to 22 August 1997) along Kilauea's Eastern Rift Zone (ERZ).

Petrologic and geochemical studies of Episode 54 lavas require the presence of an evolved, cpx- plag-saturated, low wt.% MgO magma at Pu'U 'O'o, followed by recharge of the magmatic system with a primitive, high wt.% MgO magma. Geodetic modeling of the Episode 54 eruption suggests that the eruption was triggered aseismically, by slippage of Kilauea's south flank initiating extension in the rift zone. During the eight hours preceding Episode 54, this slippage created a void space uprift of Pu'U 'O'o, into which 19 million cubic meters (19 Mm^3) of magma was intruded, triggering a series of fissure eruptions in the vicinity of Napau Crater. This newly formed intrusion was derived from four sources: small contributions from magma bodies underneath Kilauea Summit (1.5 Mm^3) and Makoupuhi Crater (1.2 Mm^3), a large volume from drainback of the pre-existing Pu'U 'O'o lava pond and conduit (12.7 Mm^3), and an older, stored rift magma that I estimate (by volume closure) to be 3.7 Mm^3. Although volume estimates are uncertain by 10-20%, the best geodetic model compares very favorably with GPS data. Magma Chamber Simulator (MCS) models produced in this study adequately replicate the mineral assemblages and compositions of Episode 54 lavas, and suggest that a 5:1 mass ratio of recharge magmas to rift-stored (low-MgO) magmas is required to generate the compositions of Episode 54 lavas. These model results are in good agreement with the aforementioned geodetic models for this eruption, suggesting that MCS may be useful in constraining magma budgets at less well-monitored volcanoes.

Hydroclimate reconstruction of semi-arid Central Asia: Insights from a Kyrgyz speleothem

Abby Letts
Department of Earth Science, UCSB

Semi-arid Central Asia has been identified as a particularly vulnerable region to global climate change. However, model projections for the region have relatively high uncertainty and there is a lack of absolutely dated records to constrain the region's climatic history. In an effort to elucidate Central Asia's hydroclimate response to changes in radiative forcings, we focus on a Kyrgyz speleothem (Central Asia) that spans late Marine Isotope Stage (MIS) 10 (343–358 kyr before present). This study couples trace element, fluorescence, and calcite fabric analysis to provide insights into orbital- to decadal-scale Central Asian climate history. We find that fluorescent banding is exclusively present in columnar compact calcite and interpret these intervals to be wetter than average. Furthermore, changes in calcite fabrics correspond to shifts in trace element concentrations and correlation coefficients. The correlation between Mg and Sr varies from positive to negative depending on fabric type, whereas Mg and P are negatively correlated throughout the stalagmite. These results are consistent with the concept of prior calcite precipitation (PCP), which predicts high (low) Mg and low (high) P concentrations during relatively dry (wet) periods. Following the concept of PCP, we interpret Mg and P oscillations as shifts in hydroclimate and find that MIS 10 is characterized by millennial- to centennial-scale precipitation variability. The short-term oscillations are superimposed on an orbital-scale aridification trend observed in the Mg signal. Comparing our records with those from northern high latitude (north of our study area) and Asian monsoon regions, a consist picture emerges: an episode of relatively strong Siberian High (cold high latitude) most likely caused a southward shift of the Westerlies and intertropical convergence zone (ITCZ), resulting in decreasing precipitation over the cave site and a weak Asian Monsoon respectively. In conclusion, while elucidating the forcings of the documented millennial-to-centennial scale changes in Central Asian hydroclimate require further investigation, a strengthening of the Siberian High and, as a result, a southward shift of the Westerlies and ITCZ, provides a consistent and viable mechanism that reconciles northern high latitude, mid latitude (this study) and low latitude (Asian Monsoon) records.

1Garcia et al. (2000), J.Pet. v.41(7); Thornber (2001), Can. Min. v.39; Thornber et al. (2003), J.Pet. v.44(9).

2Owen et al. (2000), Geophys.Res.Ltrs. v.27(17); Segall et al. (2001), J.Geophys.Res. v.106(B9); Desmarais & Segall (2007), Bull. Volcanol. v.69.